

Economic Evaluation of Palliative Management versus Peritoneal Dialysis and Hemodialysis for End-Stage Renal Disease: Evidence for Coverage Decisions in Thailand

Yot Teerawattananon, MD,^{1,2} Miranda Mugford, DPhil,² Viroj Tangcharoensathien, PhD¹

¹Ministry of Public Health, Nonthaburi, Thailand; ²University of East Anglia, Norwich, UK

ABSTRACT

Objective: To examine the value for money of including peritoneal dialysis (PD) or hemodialysis (HD) into the universal health insurance scheme of Thailand.

Methods: A probabilistic Markov model applied to end-stage renal disease (ESRD) patients aged 20 to 70 years was developed to examine the incremental cost-effectiveness ratio (ICER) of palliative care versus 1) providing PD as an initial treatment followed by HD if complications/switching occur; and 2) providing HD followed by PD if complications/switching occur. Input parameters were extracted from a national cohort, the Thailand Renal Replacement Therapy Registry, and systematic reviews, where possible. The study explored the effects of uncertainty around input parameters, presented as cost-effectiveness acceptability frontier, as well as the value of obtaining further information on chosen parameters, i.e., partial expected value of perfect information.

Results: Using a societal perspective, the average ICER of initial treatment with PD and the average ICER of initial

treatment with HD were 672,000 and 806,000 Baht per quality-adjusted life-year (QALY) gained (52,000 and 63,000 purchasing power parity [PPP] US\$/QALY) compared with palliative care. Providing treatments for younger ESRD patients resulted in a significant improvement of survival and gain of QALYs compared with the older aged group. The cost-effectiveness and cost-utility ratios of both options for the older age group were relatively similar.

Conclusions: The results suggest that offering PD as initial treatment was a better choice than offering HD, but it would only be considered a cost-effective strategy if the social willingness-to-pay threshold was at or higher than 700,000 Baht per QALY (54,000 PPP US\$/QALY) for the age 20 group and 750,000 Baht per QALY (58,000 PPP US\$/QALY) for age 70 years.

Keywords: dialysis, economic evaluation, renal failure, Thailand, value of information.

Introduction

The treatment of end-stage-renal disease (ESRD) is recognized as a major economic and political challenge in health care [1]. Renal replacement therapy is essential to many patients suffering from ESRD. It is, however, one of the most expensive health technologies [2]. Unsurprisingly, policy analysis and economic evaluation of ESRD treatment is among the first interventions to have been assessed, and evaluations have been performed regularly in many settings worldwide [3–15].

There are three major treatment modalities for patients with ESRD: peritoneal dialysis (PD), hemodialysis (HD), and kidney transplantation. A number of previous studies confirmed that kidney transplantation was the most cost-effective strategy and considered the

preferable choice [3–8]. In many settings, however, including Thailand, the number of kidney donors is insufficient to meet demand. There are around 200 donated kidneys available each year compared with the current incidence of 10,000 ESRD patients per year [16,17].

Thailand has been providing universal health-care coverage through a tax-based universal health insurance scheme (UC) since 2001 [18]. The scheme protects a population of 45 million who are not eligible for Civil Servant Medical Benefit Scheme (CSMBS) or Social Security Scheme (SSS). Although all treatment modalities for ESRD are currently covered by CSMBS and SSS, none of them is included in the UC benefit package [19]. To date, there is strong pressure from various stakeholders to provide universal access to PD and HD for UC beneficiaries [20].

This study is one of a series of studies supported by the National Health Security Office (NHSO) to provide scientific evidence for policymakers to make decisions on whether to provide dialysis treatments for

Address correspondence to: Yot Teerawattananon, International Health Policy Program, Ministry of Public Health, Tiwanon Road, Nonthaburi 11000, Thailand. E-mail: yot@ihpp.thaigov.net or yot.teera@hotmail.com

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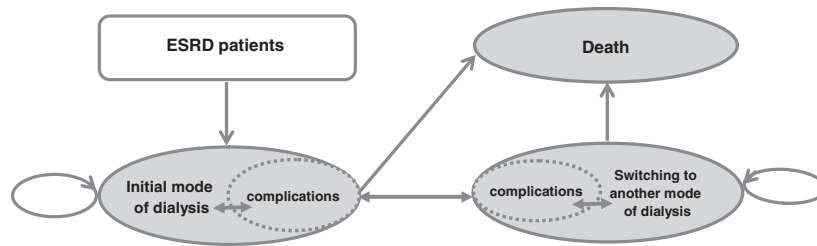


Figure 1 Schematic diagram of the Markov model.

ESRD patients under UC. Using both the NHSO's and a societal perspective, the objective of this study was to assess the value for money of providing PD and HD for UC patients versus the current practice, i.e., palliative care.

Design and Methods

Overview Options

The standard practice ("palliative care" option) includes restricted fluid intake, high-dose diuretic, antihypertensive drugs, calcium, bicarbonate, ferrous sulfate, blood transfusion, and hospital admission, if required. Previous evidence has indicated 50% mortality within 1 to 3 months [19].

Peritoneal dialysis has two main treatment varieties, either with manual exchange of dialysis fluid (continuous ambulatory peritoneal dialysis—CAPD) or with automated exchange of dialysis fluid at night. Only CAPD is offered in Thailand so it has been included in the analysis [17].

Hemodialysis can be carried out in a hospital, dialysis center, a satellite unit, or in a patient's home. Hospital and in-center dialysis, however, are the only options currently available in Thailand [17]. At the end of 2004, 301 hospitals and dialysis centers, at least one in every province, offered HD [21].

Analyses and Model

The traditional approach of economic evaluation, incremental cost-effectiveness analysis, which compares additional costs and health outcomes of moving from one intervention to alternatives, may be inappropriate in this case [2]. Because PD and HD are not complete substitutes, patients assigned for PD may require HD while complications such as peritonitis occur, and vice versa. Hence, this study evaluated the incremental cost and effectiveness of moving from current practice, palliative care, versus 1) providing PD as initial care followed by HD if complications/switching occur; and 2) providing HD as initial care followed by PD if complications/switching occur.

We developed a decision-analytic model and applied it to ESRD patients aged 20 to 70 years. The model was used to quantify the costs and effects of the two alternative long-term managements for ESRD, starting either with PD or with HD, for each patient

age group. The Markov model structure shown in Figure 1 illustrates the mutually exclusive health states that a patient commencing treatment on either PD or HD may go through, respectively. The states of health are denoted in the solid-line ovals. We also developed substates (dotted-line ovals) to reflect the difference in rates of complications between the two treatment modalities. An arrow indicates that movement from one state to another is possible. The movement between each state is determined by probabilities that were obtained from a national cohort, the Thailand Renal Replacement Therapy (TRT) Registry, and systematic reviews, where possible. Because both PD and HD are lifelong treatments, the model used a 1-year-cycle length for full health state and 1 month for complication substates.

In the model, patients may start either with PD or with HD and remain on the same treatment for the next cycle. Some patients, however, may experience complications for a month at anytime during a year cycle. The move between treatments or entry into the final state (death) may or may not be related with the occurrence of complications. Patients may die of non-ESRD causes, such as cardiovascular disease, or patients may move to another treatment because of dialysis complications, such as catheter-related infections (for HD) or peritonitis (for PD), or patients may have nonmedical limitations, such as moving to a new place where there is no hemodialysis available. In each case, it was assumed that the event would only happen at the end of each cycle.

Monte Carlo simulation was used to model costs and events over a 99-year period to cover the total period over which the whole cohort would be expected to survive.

To comply with the guideline set beforehand for conducting this health economic evaluation [22], and to be comparable with other economic evaluations [23], all costs and outcomes were discounted at the rate of 3.5%. We, however, also explored results with the discount rates of 0% and 6%.

Outcome Measures

From the review, we found only one small randomized controlled trial (38 patients) that investigated the relative efficacy of PD and HD and found no significant difference in 5-year survival (95% confidence interval

of hazard ratio between 0.8 and 15.4) after adjusting for age and comorbidities [24]. A systematic review conducted by MacLeod et al. also shows that existing data are not available to allow reliable conclusions to be drawn about the relative effectiveness of PD and HD [25]. There are still conflicting results in the literature of nonrandomized observational studies, but when data are adjusted for comorbid conditions they show no significant difference in patient survival on PD and HD [25,26]. Our assumption, based on these sources, is that PD and HD are equally effective in terms of patient survival.

Using this assumption, we estimated survival rates for a hypothetical cohort of patients from the TRT Registry undergoing dialysis. The national database consisted of records of 6272 patients who underwent dialysis from 1997 to 2003. In our analyses, we assumed all patients as having similar treatment. This does not result in biased estimators of survival but may underestimate variance. Given limitations of the database, we can only focus on patients' age at the start of dialysis as a covariate that might potentially affect patient prognosis.

Using the statistical software package STATA (Stata Corp, College Station, TX), we initially applied the nonparametric Kaplan–Meier approach [27] to fit Kaplan–Meier curves and plot graphs of

$\log[-\log\{S(t)\}]$ against $\log(\text{time})$, which were generally linear, indicating that a Weibull survival model would adequately fit the data [28]. We consequently used the “streg” module of the software to perform maximum likelihood estimations for parametric regression of the Weibull survival models (see Table 1).

For the Weibull distribution, the survival function, which describes the probability of survival as a function of age [29], is

$$S(t) = \exp[-H(t)]$$

and

$$H(t) = \lambda t^\gamma$$

where $H(t)$ is the cumulative hazard; λ (lambda) is the scale parameter; t is time in days; and γ (gamma) is the shape parameter that describes the instantaneous death rate, the hazard rate $h(t)$, which increases with age if $\gamma > 1$. λ depends on the covariate, age, according to the formula

$$\lambda = \exp[(\text{age_coefficient} \times \text{Age}) + \text{cons}]$$

The transitional probability of dying during the cycle, $tp(c)$, is therefore estimated from the following formula (where c is the number of cycle):

$$tp(c) = 1 - \exp[H(t - c) - H(t)]$$

Table 1 Means and standard error (SE) of input parameters

Parameters	Mean	SE	Parameter distribution	Data source
Weibull survival				
Constant value for baseline hazard	-11.1771	0.2439	LogNormal	TRT
Age coefficient for baseline hazard	0.0347	0.0021	LogNormal	TRT
$\ln(\gamma)$	0.0722	0.0247	LogNormal	TRT
Transitional probabilities				
Monthly probability of dying among patients with palliative care	0.331	0.1509	Beta	[19]
Annual rate of having complications among PD patients	0.3294	0.5739	Gamma	[32]
Annual rate of having complications among HD patients	0.2698	0.5194	Gamma	[19]
Annual probability of switching from PD to HD	0.0270	0.0054	Beta	TRT
Annual probability of switching from HD to PD	0.0064	0.0011	Beta	TRT
Direct health-care costs				
Lifetime costs of palliative care	18,000	18,000	Gamma	[19]
Set-up costs for PD, e.g., peritoneal catheter implantation	47,000	15,000	Gamma	Survey
Set-up costs for HD, e.g., arteriovenous graft	21,000	7,000	Gamma	Survey
Annual maintenance cost for PD	356,000	45,000	Gamma	[33] and survey
Annual maintenance cost for HD	380,000	132,000	Gamma	[38]
Total (monthly) cost of treating PD complications	32,000	24,000	Gamma	[33] and survey
Total (monthly) cost of treating HD complications	15,000	15,000	Gamma	[33] and survey
Annual cost of treating comorbidities, e.g., diabetes	40,000	29,000	Gamma	[33,39]
Direct non-health-care costs, e.g., travel costs				
Lifetime cost paid by household with palliative care	35,000	35,000	Gamma	[39]
Annual cost paid by household with PD	5,000	1,000	Gamma	[39]
Annual cost paid by household with HD	33,000	8,000	Gamma	[39]
Indirect non-health-care costs, e.g., costs of sick leave				
Annual cost paid by household with PD	3,000	600	Gamma	
Annual cost paid by household with HD	41,000	8,000	Gamma	[39]
Utility parameters				
Utility for PD without complication	0.72	0.08	Beta	[33–36]
Utility for HD without complication	0.68	0.10	Beta	[33–36]
Utility for patients with palliative care/dialysis with complications	0.60	0.15	Beta	[33–36]

TRT, Thailand Renal Replacement Therapy Registry.

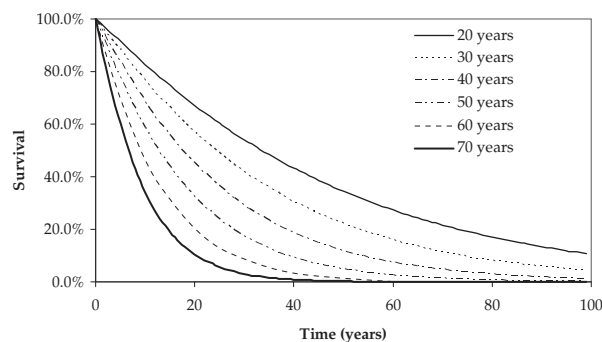


Figure 2 Survival graphs by age group (up to 4 years and projected using the Thailand Renal Replacement Therapy Registry).

The survival graphs shown in Figure 2 reveal that the mortality rates were predicted to be high among older patients and increased with age. In this figure, however, it can be observed that for all age groups a great proportion of the cohort reaches 100 years or more. For example, about 20% of the age 20 group survives up to 100 years, which is not consistent with the national figures for life expectancy in the general population [30].

This is a common problem found in the modeling of survival when the length of follow-up of empirical data is insufficient to capture enough events (4 years for this case) [31]. An explanation is that the hazard rate used in the study is for all-cause mortality, so that for younger dialysis patients the total mortality rate is mostly mortality due to ESRD, whereas for older patients there will be a significant risk of mortality due to other causes, e.g., cardiovascular problems. Using the mortality hazard for age 20 years starting dialysis to estimate their survival for 99 years may underestimate their risk of mortality due to non-ESRD causes.

As an alternative, we estimated another survival model that allowed patients to move between estimated survival curves in Figure 2 as their age increases. The adjusted survival graph from the new model is presented in Figure 3, which shows more realistic estimations. We applied survival from both models in turn in our analyses.

Analysis of the national database indicated that the annual probability of switching from PD to HD was 0.0270 (SE 0.0054) and the probability of switching from HD to PD was 0.0064 (SE 0.0011).

The rate of complications among those with PD and HD was not routinely reported in the TRT Registry. Therefore, we did a systematic search of national literature from MUCC-OPAC (Mahidol University), Chulalinet (Chulalongkorn University), CMUL OPAC (Chiangmai University), INNOPAC web (Khon Kaen University), and OPAC PSU (Prince of Songkla University) using the keywords “dialysis,” “renal dialysis,” “hemodialysis,” and “peritoneal dialysis.” Two independent researchers reviewed whether all abstracts and

full manuscripts matched the inclusion criterion previously set by the team. If more than one study were identified, meta-analysis of data was proposed.

The annual rate of having peritonitis among patients with PD was 0.3294 (SE 0.5729) [32] and the annual rate of having vascular access-related complications among patients with HD was 0.2698 (SE 0.5194) [19].

Based on an assumption of a short half-life of patients with palliative care (1–3 months) [19], the mean and SE of the monthly probability of ESRD patients dying without dialysis were 0.3331 and 0.1509, respectively.

Quality-Adjusted Survival

We adjusted outcomes for quality of life (QoL) using published utility estimates from a systematic search of similar databases and keywords used in outcome measures. We identified 12 studies reporting QoL for ESRD patients but subsequently excluded eight studies in which results were not presented to compare QoL among treatment strategies and/or were only qualitative descriptions. Finally, we included the four remaining studies, all of which interviewed ESRD patients. All studies employed multiattribute utility measurements, e.g., Health Utility Index, EQ-5D [33–36]. Meta-analysis using a random effects approach found that the QoL of ESRD patients without dialysis was 0.60 (SE 0.15). Without complications, the QoL of patients with PD was 0.72 (SE 0.08) and the QoL of patients with HD was 0.68 (SE 0.10). No study reported the QoL of patients with dialysis and complications. We applied the QoL of patients without dialysis to those with dialysis and complications.

Costs

Costs were derived from a systematic search of Thai published and gray literature, selecting the most up-to-date reports. They included all items of resources used, i.e., capital, labor and material costs of health-care providers, and real and opportunity costs lost by patients and relatives, i.e., patient treatment time, time for informal care, and cost for sick leave.

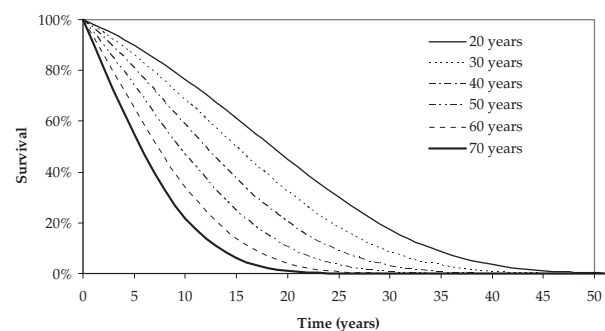


Figure 3 Adjusted survival (allowing patients to move between survival curves in Figure 2 as their age increases) using sensitivity analysis.

In addition, although most economic evaluations include future costs only for related illnesses [37], we considered that the cost of unrelated medical care might be considerable in this particular case because the interventions increase length of life and the patient population is likely to have comorbidities, e.g., diabetes or cardiovascular disease. Hence, we counted the cost of treating comorbidities as a program cost for each extended life-year (LY).

Briefly, the provider's costs for offering HD and PD were from a national costing survey carried out by Tisayathikom et al. [38] and from a master's degree thesis by Sriwajana [33], while the patient's costs were from a study conducted by Homvijitkul [39]. We also conducted a micro-costing survey in two public hospitals (Prince of Songkla hospital and ChiangKhum hospital) and one private hospital (Viphavadee hospital) for cost items where no published data were identified.

All costs shown in Table 1 are reported in 2004 Thai Baht for each state of health within the Markov model. For intercountry comparison, costs have been converted into international dollars using purchasing power parity (PPP) US\$ exchange rates at 1 US\$ (2004) = 12.868 Thai Baht [40].

Uncertainty Analysis

A probabilistic sensitivity analysis using a second-order Monte Carlo simulation was carried out in Microsoft Office Excel 2003 (Microsoft Corp., Redmond, WA) [29]. All input parameters were assigned a probability distribution to reflect the feasible range of values that each input parameter could attain [41]. The beta-distribution was the choice of distribution for probability and utility parameters, which were bounded zero—one, and the gamma-distribution, which ensures positive values, was modeled for all rate and unit cost parameters. The normality on the log-odds scale with covariance matrix and Cholesky decomposition [42] was applied for survival parameters.

The simulation then drew one value from each distribution simultaneously and calculated cost and effectiveness pairs. This process was repeated 1000 times to provide a range of possible values given the specified probability distributions. Because there is no linear relationship between inputs and outputs in the Markov model [43], all costs, outcomes, and cost-effectiveness ratios provided in the Results section are expressed as the average value from the probabilistic sensitivity analysis.

Furthermore, because net benefits are not always normally distributed, a cost-effectiveness acceptability curve may wrongly present some strategies as suboptimal, but which have a higher probability of being cost-effective [44]. Thus, the results are presented as a cost-effectiveness acceptability (CEAcc) frontier, which determines the intervention giving the maximum

expected net benefit for each value of the ceiling ratio [29].

We also determined an uncertain parameter's importance using the utility theory framework. The analysis of partial expected value of perfect information (EVPI) was performed to determine whether different values of a particular input parameter lead to different optimum decisions, and if so, how much the expected loss under alternative optimum decisions varies [45,46].

If θ is the set of parameters for the model, with defined prior probability distributions; t is the set of possible decisions or strategies; and $NB(t, \theta)$ is the function of net benefit for decision t and parameters θ , the expected net benefit given no further information can be written as

$$\max_t [E_\theta NB(t, \theta)]$$

The expected net benefit given full information is

$$E_\theta [\max_t NB(t, \theta)]$$

and overall EVPI equals to

$$E_\theta [\max_t NB(t, \theta)] - \max_t [E_\theta NB(t, \theta)]$$

This is expressed in Baht per patient. To give a final value for the Thai context, we then multiplied by the incidence of 10,000 new ESRD cases per year and assumed that the current technology would be in operation for 10 years [19].

To quantify the value of obtaining further information on chosen parameters, partial EVPI is the difference between the expected value of a decision made with perfect information about a particular vector of the parameters (θ) and the current optimal decision [47].

With perfect information θ_i is the known vector of the parameters of interest, θ ; then the expected benefit of a decision made would now be found by averaging over the uncertainty in θ that remains once we know θ_i and then by selecting the optimal treatment that provides maximum expected net benefit:

$$\max_t [E_{\theta|\theta_i} NB(t, \theta)]$$

At this stage, however, we do not have perfect information on θ_i , so the expected value of a decision made with perfect information about θ_i is found by averaging over the uncertain ranges of the parameters θ_i and can be presented as

$$E_{\theta_i} [\max_t E_{\theta|\theta_i} NB(t | \theta)]$$

The additional value of collecting perfect information on a subset θ_i of uncertain model parameters is therefore given by the following equation:

$$E_{\theta_i} [\max_t E_{\theta|\theta_i} NB(t | \theta)] - \max_t [E_{\theta|\theta_i} NB(t, \theta)]$$

The analysis of partial EVPI requires an explicit statement of the value of the ceiling ratio, and because,

Table 2 Lifetime cost for providing peritoneal dialysis and hemodialysis as an initial treatment by age group and view point of analysis

Age (year)	Unadjusted survival				Adjusted survival			
	Peritoneal dialysis		Hemodialysis		Peritoneal dialysis		Hemodialysis	
	Societal perspective	NHSO's perspective	Societal perspective	NHSO's perspective	Societal perspective	NHSO's perspective	Societal perspective	NHSO's perspective
20	8,277,000	7,804,000	9,286,000	7,956,000	8,277,000	7,804,000	9,286,000	7,956,000
30	7,262,000	6,823,000	8,206,000	7,013,000	7,262,000	6,823,000	8,206,000	7,013,000
40	6,135,000	5,737,000	6,997,000	5,807,000	6,135,000	5,737,000	6,997,000	5,807,000
50	5,062,000	4,826,000	5,771,000	5,028,000	5,062,000	4,826,000	5,771,000	5,028,000
60	4,096,000	3,901,000	4,696,000	4,011,000	4,096,000	3,901,000	4,696,000	4,011,000
70	3,286,000	3,126,000	3,775,000	3,235,000	4,233,000	3,126,000	4,353,000	3,235,000

Costs are given to nearest 1000 Baht, 2004 price levels.

The figures are not incremental but absolute numbers. Conversion to incremental values compared with palliative care can be performed by subtracting 224,000 Baht for a societal perspective and 72,000 Baht for the NHSO's perspective for all age groups.

NHSO, National Health Security Office.

unfortunately, there is no such accepted threshold for adopting health technologies in Thailand, we applied the threshold that is recommended by the commission on Macroeconomics and Health, which suggests the use of three times of gross domestic product (GDP) per capita as the threshold for consideration in developing countries [48]. This would indicate a ceiling value in Thailand of 270,000 Baht per quality-adjusted life-year (QALY) based on 2004 Thai GDP and population [49].

Results

Using the government perspective, the total program cost of palliative care was 72,000 Baht, accounting for 32% of the program cost from a societal perspective (224,000 Baht). The palliative care option yielded 0.34 life-year (LY), or 0.20 QALY. These costs and outcomes of palliative care were equivalent for all age groups.

Compared with providing PD as the first-line treatment, the introduction of HD offered more health benefits, LYs saved, and QALYs gained, and was more costly for all age groups (Tables 2 and 3). Total lifetime costs borne by the NHSO accounted for 95% for offering PD as an initial treatment, and 85% for offering HD as an initial treatment, for all age groups, resulting in comparable economic evaluation results

both using either the NHSO's or a societal viewpoint. Given the effects of discounting on long-term costs, it is noteworthy that the lifetime costs derived from the model with unadjusted survival and the model with adjusted survival were similar. This is shown in Tables 4 and 5.

Both for models with adjusted and nonadjusted survival, the incremental costs of providing the "PD first" option ranged from 466,000 Baht per LY saved or 667,000 Baht per QALY gained for patient aged 20 years to 497,000 Baht per LY or 700,000 Baht per QALY gained for patient aged 70 years using a societal perspective. Slightly higher, i.e., less favorable, cost-effectiveness and cost-utility ratios were observed if "HD first" is introduced in the UC benefit package.

Uncertainty Analysis

The results of the probabilistic sensitivity analysis using a societal viewpoint are presented by CEAcc frontier in Figure 4. We compared the simulation results for patients aged 20 years (black line) with those for patients aged 70 years (gray line), which are quite similar, with one exception. The CEAcc frontier suggests that for ceiling ratios less than 650,000 and 700,000 Baht per QALY for age groups 20 and 70 years, respectively, providing care without dialysis for ESRD patients was the most appropriate. If policymakers are, however, willing to pay more than

Table 3 Health outcomes of providing peritoneal dialysis and hemodialysis as an initial treatment by age group

Age (year)	Unadjusted survival				Adjusted survival			
	Life-years gained		QALYs gained		Life-years gained		QALYs gained	
	Peritoneal dialysis	Hemodialysis	Peritoneal dialysis	Hemodialysis	Peritoneal dialysis	Hemodialysis	Peritoneal dialysis	Hemodialysis
20	17.65	17.65	12.27	11.89	17.65	17.65	12.32	11.89
30	15.32	15.32	10.67	10.25	15.34	15.34	10.71	10.26
40	12.96	12.96	9.03	8.67	12.93	12.93	9.01	8.65
50	10.60	10.60	7.44	7.14	10.58	10.58	7.42	7.11
60	8.45	8.45	5.92	5.70	8.41	8.41	5.92	5.65
70	6.53	6.53	4.60	4.38	9.21	9.21	6.43	6.13

The figures are not incremental but absolute numbers. Conversion to incremental values compared with palliative care can be performed by subtracting 0.34 for life-year gained and 0.20 for QALY for all age groups.

QALYs, quality-adjusted life-years.

Table 4 Results of economic evaluation of providing peritoneal and hemodialysis as an initial treatment compared to palliative care, using the societal perspective

Age (year)	Unadjusted survival				Adjusted survival			
	Baht per life-year saved		Baht per QALY gained		Baht per life-year saved		Baht per QALY gained	
	Peritoneal dialysis	Hemodialysis	Peritoneal dialysis	Hemodialysis	Peritoneal dialysis	Hemodialysis	Peritoneal dialysis	Hemodialysis
20	466,000	525,000	667,000	777,000	466,000	525,000	667,000	777,000
30	470,000	533,000	671,000	795,000	470,000	533,000	671,000	795,000
40	470,000	539,000	672,000	803,000	470,000	539,000	672,000	803,000
50	473,000	543,000	672,000	806,000	473,000	543,000	672,000	806,000
60	480,000	555,000	677,000	821,000	480,000	555,000	677,000	821,000
70	497,000	575,000	700,000	850,000	497,000	575,000	700,000	850,000

Costs are rounded up to nearest 1000 Baht, 2004 price levels.

QALY, quality-adjusted life-year.

Table 5 Results of economic evaluation of providing peritoneal and hemodialysis as an initial treatment compared to palliative care, using NHSO's perspective

Age (year)	Unadjusted survival				Adjusted survival			
	Baht per life-year saved		Baht per QALY gained		Baht per life-year saved		Baht per QALY gained	
	Peritoneal dialysis	Hemodialysis	Peritoneal dialysis	Hemodialysis	Peritoneal dialysis	Hemodialysis	Peritoneal dialysis	Hemodialysis
20	447,000	456,000	641,000	675,000	447,000	456,000	641,000	675,000
30	451,000	463,000	645,000	691,000	451,000	463,000	645,000	691,000
40	449,000	455,000	643,000	678,000	449,000	455,000	643,000	678,000
50	463,000	483,000	657,000	714,000	463,000	483,000	657,000	714,000
60	472,000	486,000	670,000	716,000	472,000	486,000	670,000	716,000
70	495,000	512,000	696,000	759,000	495,000	512,000	696,000	759,000

Costs are rounded up to nearest 1000 Baht, 2004 price levels

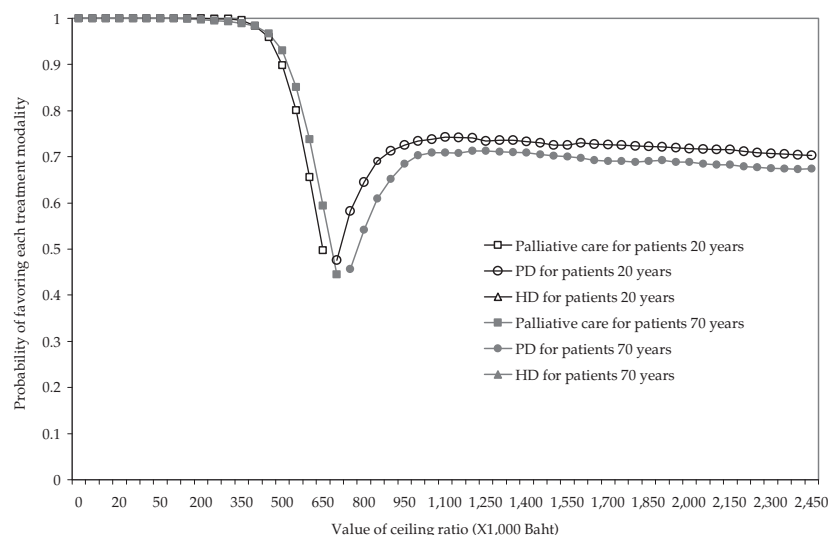
NHSO, National Health Security Office; QALY, quality-adjusted life-year.

700,000 Baht per QALY for age group 20 years and 750,000 Baht per QALY for age group 70 years, providing “PD first” was the optimal choice.

With the existence of uncertainty around input parameters of alternative treatment modalities, Figure 5 illustrates the expected opportunity loss of making a wrong decision for patients aged 50 years (the average age among ESRD patients in Thailand). Overall EVPI of treating 10,000 new ESRD cases per year and for a 10-year time period was highest

(260,000 million Baht) at a ceiling ratio of 650,000 Baht per QALY.

Because it was certain that palliative care was the best option at the ceiling ratio of 270,000 Baht per QALY (Fig. 5—overall EVPI = 0 at the ceiling ratio 270,000 Baht), there is no partial EVPI at that particular threshold. We, however, decided to examine the importance of each input parameter in the model, at least, as a proxy for future research in other settings. Thus, we took the point of maximum overall EVPI

**Figure 4** Cost-effectiveness acceptability frontier.

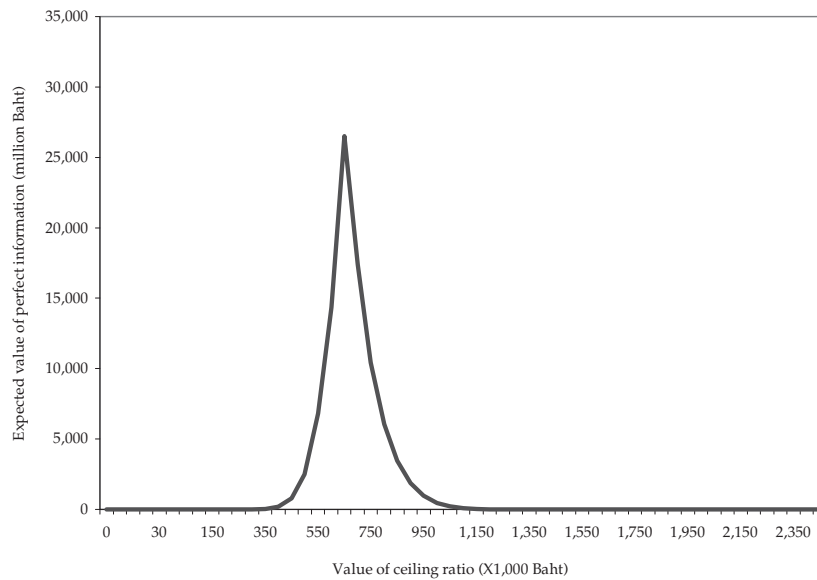


Figure 5 Population expected value of perfect information for a model using the 50 years age group with adjusted survival.

(ceiling ratio of 650,000 Baht per QALY) to quantify the expected additional value of collecting perfect information on each input parameter, partial EVPI.

Figure 6 reveals that, among all uncertain model parameters, the maintenance cost of the PD and HD options were the parameters with the first and second highest partial EVPI, respectively. Utility values for patients treated by PD and HD, costs of treating

comorbidity, and survival function were among the important parameters.

Because it is debatable whether to include future unrelated medical care costs resulting from lifesaving interventions when performing economic evaluations [37,50], in our analysis we thus assessed the impact of excluding the costs of treating comorbidities for each LY gained. We found that, without the costs of treating

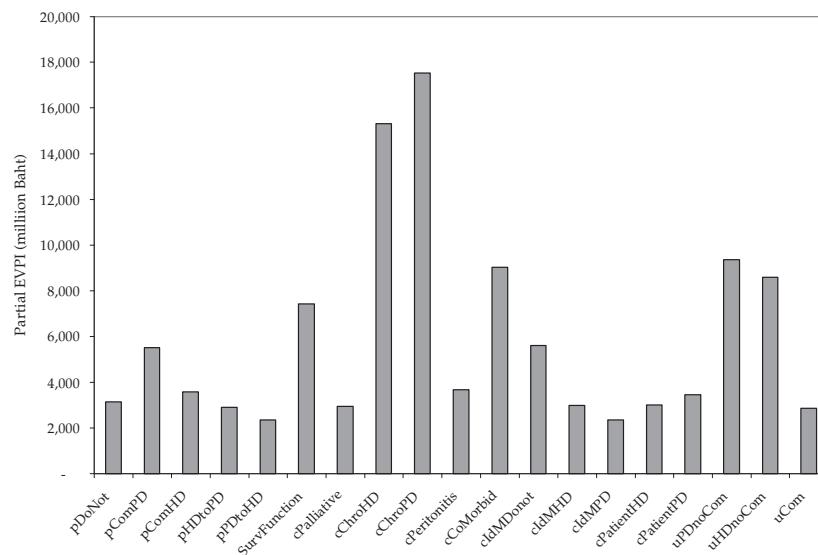


Figure 6 Expected value of perfect information (EVPI) for input parameters. pDoNot, probability of dying among patients with palliative treatment; pComPD, rate of having complications among PD; pComHD, rate of having complications among HD; pHDtoPD, probability of switching from HD to PD; pPDtoHD, probability of switching from PD to HD; SurvFunction, survival estimation; cPalliative, health-care cost of palliative care; cChroHD, health-care cost of hemodialysis; cChroPD, health-care cost of peritoneal dialysis; cPeritonitis, health-care cost of treating PD complications; cCoMorbid, health-care cost of treating comorbid conditions; cIdMDonot, direct non-health-care cost of palliative treatment; cIdMHD, direct non-health-care cost of hemodialysis; cIdMPD, direct non-health-care cost of peritoneal dialysis; cPatientHD, indirect non-health-care cost of hemodialysis; cPatientPD, indirect non-health-care cost of peritoneal dialysis; uPDnoCom, utility for PD without complication; uHDnoCom, utility for HD without complication; uCom, utility for patients with complications.

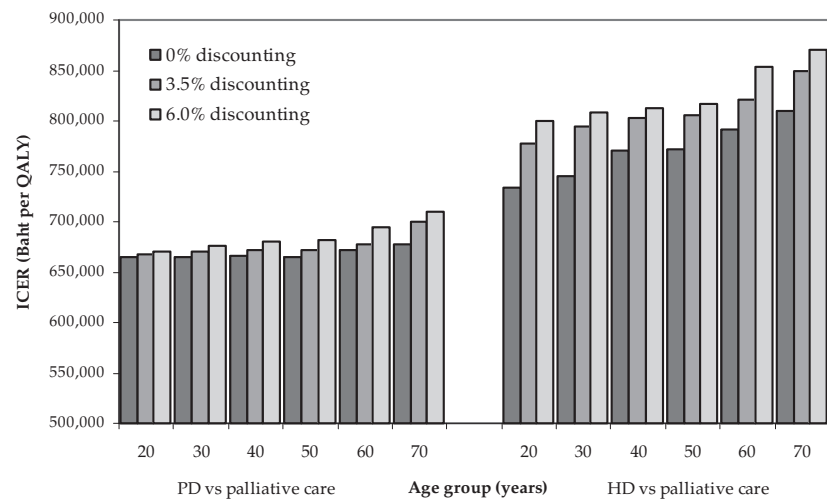


Figure 7 Incremental cost-effectiveness ratios (ICER) using different discount rates by age group. Note: to present the differences of the results, we modified scale in x-axis starting with 500,000 Baht per QALY.

comorbidities, all ICERs of both PD and HD in terms of Baht/LY gained and Baht/QALY gained were reduced around 9% to 10% across age groups (because the model used no age-specific average medical care costs).

In the analysis using the alternative discount rates of 0% and 6%, we found that the rates above and below the actual discount rate used for the reference case (3.5%) had no impact on the overall conclusions—offering PD as an initial treatment was always superior to HD for all age groups, and providing treatment to younger patients was superior to that for elders (see Fig. 7). Furthermore, although there was not much difference among ICERs using different discount rates, it can be seen that the lower the rate of discounting the lower the ICER.

Discussion

The results indicate that the government should not include dialysis services for ESRD patients unless social willingness to pay or the ceiling ratio is at or higher than 700,000 Baht per QALY for young patients (age 20 years) and 750,000 Baht per QALY for older people (age 70 years). Although, there is no agreed threshold for adopting health technologies in Thailand, the threshold of 700,000 is almost three times higher than that recommend by the commission on Macroeconomics and Health.

If decision-makers are willing to pay 700,000 Baht per QALY or more, then providing PD as an initial treatment is the optimal decision because it dominated the HD option at any value of the ceiling ratio given the assumption of equal survival between PD and HD.

In subgroup analysis, it is interesting to note that providing treatments for younger ESRD patients resulted in a significant improvement of survival and gain of QALYs compared with the older age group. We found, however, that cost-effectiveness and cost-utility

ratios among all subgroups were relatively similar. This could be explained, as Manns et al. [50] pointed out, by the fact that the inclusion of future costs, i.e., costs of dialysis of extended survival, would largely affect the economic evaluation results, so that even relatively inexpensive interventions that extend the survival of dialysis patients may not be cost-effective, as long as the treatment must be continued.

At this stage, no final decision has been made by Thai government whether to include PD or HD in the UC benefit package. We believe that this evidence needs to be considered alongside other policy issues, e.g., equity grounds, ethical principles, or financial implications, all of which are being considered. The NHSO is also considering launching a process of national consensus, in 2006, through a series of public hearings, to solicit public opinions on the rationing of care for ESRD patients in Thailand.

The results of this study are not in agreement with the conclusion made by Winkelmayer et al. [2]. They reviewed 13 economic evaluation studies on renal replacement therapy published between 1968 and 1998 and concluded that the cost-effectiveness of center hemodialysis were within a narrow range of US\$55,000 to US\$80,000 per LY saved (all figures were adjusted using PPP US\$ exchange rate). Our study found a lower figure for Thailand (US\$43,000 per LY saved). This finding could possibly be explained by the fact that the study of Winkelmayer et al. was dominated by evidence from developed countries, because 12 out of 13 studies were conducted in United States, United Kingdom, Canada, Sweden, New Zealand, and The Netherlands.

Nevertheless, our results are still higher than the results of a study conducted in Brazil [5], which was included in the work of Winkelmayer et al., and a newer publication from Malaysia [51]. Using a provider (NHSO) perspective, our study finds that the cost-effectiveness of PD and of HD were US\$37,000

and US\$38,000 per LY saved. The Brazilian study indicated that the cost-effectiveness of PD and of HD were US\$12,000 and US\$11,000 per LY saved, respectively, and a recent report by Hooi [50] revealed that the cost-effectiveness of PD and of HD in Malaysia were US\$8000 and US\$9000 (2001) per LY saved. These differences may partly be explained by the fact that the Brazilian and Malaysian studies did not include future medical costs of treating comorbidities from extended LYs.

There are some limitations regarding the availability of data used in the model. We carried out subgroup analysis by modeling age-specific survival from the TRT Registry, but we have no information available to model age-specific expenditures. Thus, the model applied the same provider and patient costs for all subgroups. Using non-age-specific costs may have underestimated or overestimated some cost items, e.g., cost for sick leave or cost of treating comorbidities, which are expected to vary across age groups.

Nevertheless, it is arguable that the magnitude of cost-effectiveness and cost-utility ratios were largely dependent on the estimated future cost of dialysis, PD or HD, and these costs were likely to be comparable across all subgroups. Also, although costs applied in the analysis included all items of resources used, the costs of staff training, which would be large for this particular form of care, were excluded.

Furthermore, we assumed independence between the occurrence of complications and switching between treatment modalities in the model. Thus, it is likely to have had an impact on the probabilistic sensitivity analysis and the CEAcc frontier.

Because we wanted to use Thai data and perform sub-age group analysis, and because there is no effectiveness evidence from randomized controlled trials or meta-analysis available to perform that, we had to estimate effectiveness from the registry database, which gives an equal survival for PD and HD. This approach, however, does not allow analysts to explore the uncertainty surrounding the effectiveness of each treatment and to quantify its impact and value for obtaining more information. As a result, we recommend that a high quality synthesis of the evidence on PD versus HD survival should be conducted.

Finally, the utility value for dialysis with complications is assumed equal to the utility of having no dialysis, which may have underestimated the uncertainty in this parameter. Nevertheless, given the rare incidence and relatively short duration of dialysis with complications, we still believe that the utility of dialysis with complications would have little effect on the overall results, as indicated by the partial EVPI analysis.

We believe that the methods and results of this study provide an important contribution to the evaluation of the value for money of alternative modes of

management of ESRD patients in Thailand and other health-care settings, especially in developing countries, where such evidence is rarely available. The methods used in this study can be applied to future evaluations of health-care technologies.

There are two features of the methods that deserve particular emphasis. First, rather than evaluating PD or HD alone, we evaluated the value for money of providing PD or HD as the first-line treatment, which permits patients subsequently to move between treatment modalities. For example, we found that among people whose initial treatment modality was PD, 77% of their time on dialysis (LY saved) was from PD, while among people initially treated by HD 96% of their LY saved was from HD. This approach allows the evaluation of policy options known as “adoption decision” rather than assume adherence to a particular technology. In our model, both technologies would need to be available but used at different levels.

Second, the study extensively evaluated the effects of uncertainty around input parameters, which is common in decision modeling. The model is fully probabilistic and the results are comprehensive to handle the real-life situation faced by policy decision-makers who need to make a judgment under suboptimal information. We hope that this study would also facilitate the wider use of such methods in future health economic evaluation studies so that policymakers can take the benefits from the approach.

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